Ghana - Energy Efficiency and Demand-side Management

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Overview

Identification

COUNTRY
Ghana

EVALUATION TITLE
Energy Efficiency and Demand-side Management

EVALUATION TYPE
Independent Evaluation

ID NUMBER
DDI-MCC-GHA-IE-ENERGY-EEDSM-2019-v01

Version

VERSION DESCRIPTION
- v01: Edited, anonymous dataset for public distribution.

Overview

ABSTRACT
The Energy Efficiency and Demand Side Management (EEDSM) project seeks to improve building and appliance efficiency and reduce energy wastage through the introduction of standards and labels, energy audits and outreach activities. EEDSM beneficiaries include the entire population with access to electricity, an estimated 4.3 million households with 19.6 million people. The EEDSM Project consists of four activities: the Development and Enforcement of Standards and Labels activity, the Improved Energy Auditing activity, the Education and Public Information activity, and the Demand Side Management activity. The evaluation of the EEDSM project will address the following questions for each of the four interventions designed to reduce energy waste and increase the reserve margin between electricity supply and peak demand. These interventions include (1) a rollout of energy efficiency standards, (2) implementation of the pre-tertiary school curriculum and public information on use of efficient appliances with standards and labels via different media platforms, (3) implementation of an energy auditing and retrofitting activity and an intervention to establish two sustainable energy services centers (SESCs) that will train and certify energy auditors for the country, and (4) installing energy-efficient LED street lights. The methodological approach for the performance evaluation of EEDSM relies in tracking key outcomes over time, qualitative data analysis, pre-post analysis, and simulations. The impact evaluation will assess the impact of the R2R&R intervention on the electricity consumption. We will measure impacts relative to the pre-treatment period using an Interrupted Time Series (ITS) method which involves comparing outcomes before an intervention is implemented with those after. The sample for the analysis of outcomes from administrative utility data will include the intervention buildings. Evaluation questions include: 1. Have the EEDSM interventions changed consumption of electricity by individual customers? 2. Did the availability and purchases of more energy-efficient appliances increase when standards were implemented? To what extent can these changes be attributed to the new standards? 3. To what extent has the R2R&R intervention affected electricity use and bill payment rates? 4. Were project activities implemented as designed? How did implementation (in terms of objectives, activities, and beneficiaries) deviate from the original logic driving the investment, and why? How did changes in implementation affect project performance? What were the implementation successes and challenges? 5. Were improvements in project outcomes sustained after the end of the compact? What sustainability planning was done during implementation, and why? What are the critical institutional factors that affected their sustainability?

EVALUATION METHODOLOGY
Interrupted Time Series, Pre-Post, Other (Performance Evaluation)

UNITS OF ANALYSIS
Households, enterprises, schools

KIND OF DATA
SSD, ADM, OBS, PRO

TOPICS

Topic	Vocabulary	URI
Energy	MCC Sector	

KEYWORDS
Ghana, Ghana compact, power, energy, electricity, power sector reform, energy efficiency, energy demand, demand side management

Coverage

GEOGRAPHIC COVERAGE
Nationally; EEDSM beneficiaries include the entire population with access to electricity, an estimated 4.3 million households with 19.6 million people.

UNIVERSE
Implementation documents and records, KIIs, observational data, administrative data, and the household and enterprise survey.

Producers and Sponsors

PRIMARY INVESTIGATOR(S)

Name	Affiliation
Mathematica	

FUNDING

Name	Abbreviation	Role
Millennium Challenge Corporation	MCC	

Metadata Production

METADATA PRODUCED BY

Name	Abbreviation	Affiliation	Role
Mathematica			Independent Evaluator

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DDI DOCUMENT VERSION
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MCC Compact and Program

COMPACT OR THRESHOLD
Ghana II Compact

PROGRAM
The Ghana II Compact aims to improve the quality and reliability of power distribution systems; support regulatory reforms to promote private sector partnership and long-term financial sustainability; improve access to legal connections for micro, small, and medium-sized enterprises (MSMEs); and promote energy efficiency to manage demand growth. The compact comprised the four following projects designed to address critical challenges facing the electricity sector: (1) the ECG Financial and Operational Turnaround Project (EFOT), which was designed to improve ECG's management and efficiency by introducing private sector participation, reducing outages and commercial and technical losses, and modernizing the

electricity distribution system; (2) the Regulatory Strengthening and Capacity Building Project, designed to promote sustainability, transparency, and accountability in the power sector through strengthening regulatory institutions and processes, reviewing and restructuring tariffs, and improving the environment for private sector investment; (3) the Access Project, which targets MSMEs in markets and economic enclaves in urban and peri-urban areas with activities to increase legal connections and improve security lighting; and (4) the Energy Efficiency and Demand Side Management (EEDSM) Project, which seeks to improve building and appliance efficiency and reduce energy wastage through energy audits; standards and labels for energy efficient devices; upgrades to street lighting; and education and public information activities. The original design of the compact also covered the NEDCo Financial and Operational Turnaround Project (NFOT) which was designed to improve NEDCo's financial performance and customer service through private sector involvement in operational and commercial capacity building, infrastructure investments, and efforts to improve cost recovery. MiDA was not able to reach an agreement to move forward with this project, so it was de-scoped. Consequently, the funds are being reallocated, and we do not cover the project in this design report. The original design of the compact also included the Power Generation Sector Improvement (Generation) Project to diversify fuel sources for power generation through support for the gas sector and liquefied natural gas development and to strengthen the enabling environment for independent power producers (IPPs). The need for MCC assistance has been greatly reduced because the GoG is already undertaking reforms with support and technical assistance from USAID. As a result, MCC is not moving forward with this project and we do not cover it in this report.

MCC SECTOR
(Energy)

PROGRAM LOGIC
MCC's problem diagnostic identified two main issues limiting the efficiency and effectiveness of the Ghana energy sector: (1) low reliability of electricity supply and (2) insufficient access to power. The program logic for the Ghana II Compact addresses these issues. The activities are expected to achieve targeted power sector outcomes of increased availability, reliability, and expansion of cost-effective generation for all utility customers and increase the number of businesses, institutions, and households connected to the grid. The core compact activities consist of four main projects; the ECG Financial and Operational Turnaround Project, the Regulatory Strengthening and Capacity Building Project, the Energy Efficiency and Demand Side Management Project, and the Access Project. Together, these projects aim to reduce or eliminate sector inefficiencies and reliance on government subsidies, improving service as a result. If successful, these projects would improve the availability and quality of electricity to consumers while also improving the financial health of the utility. Outcomes from these activities support the Compact's goal of reducing poverty through sustainable and equitable economic growth by improving Ghana's power sector. The EEDSM project seeks to improve building and appliance efficiency and reduce energy wastage through the introduction of standards and labels, energy audits and outreach activities. EEDSM beneficiaries include the entire population with access to electricity, an estimated 4.3 million households with 19.6 million people. The four main activities include: Development and Enforcement of Standards and Labels activity, Improved Energy Auditing activity, Education and Public Information activity, and Demand Side Management activity.

PROGRAM PARTICIPANTS
EEDSM beneficiaries include the entire population of Ghana with access to electricity, an estimated 4.3 million households with 19.6 million people.

Sampling

Study Population

Implementation documents and records, KIIs, observational data, administrative data, and the household and enterprise survey.

Sampling Procedure

We will conduct a longitudinal household and enterprise survey that covers the Greater Accra area as well as the next largest 7 cities in the ECG catchment area. We will work closely with GridWatch to ensure that our sample targets locations where they are collecting outage data, when possible, and so that we can avoid surveying the same households and enterprises covered in their baseline survey and so that we can take full advantage of the data they are collecting on outages and voltage fluctuations. We will work with Ghana Statistical Service (GSS) and the World Bank to develop two sampling frames-one for households and one for businesses. We will use a multi-stage sampling plan. First we will sample enumeration areas. Second, we will sample electric poles within enumeration areas. Third, we will sample households and enterprises served by those poles. We will oversample larger enterprises to improve the precision of our data for addressing the Economic Rate of Return calculations. We will conduct Key Informant Interviews and Focus Group Discussion to help enrich our understanding of key issues. The evaluation will have three rounds of data collection, baseline in 2019, a qualitative midline in 2021 near the end of the compact, and an endline starting in 2023.

We plan to sample 2,394 enterprises in the Greater Accra area and estimate a minimum detectable effect (MDE) of 0.12 standard deviations for enterprises in that area. The minimal detectable differences (MDD) are about half as large as the MDEs for binary outcomes such as, whether the entity has a legal connection. This outcome had a mean of around 0.5 in the baseline data for the Access project. This means that we should be able to detect changes in the fraction of enterprises with a legal connection as small as 0.06 between the baseline and follow-up surveys. Given MCC's greater interest in enterprises compared to households we are aiming for a much larger MDE for households, at around 0.21 in the Greater Accra area. We are expecting to have slightly larger MDEs, of about 0.24 standard deviations, when considering samples of enterprises from smaller geographic areas-in particular when looking only at the geographic areas targeted by one of the following interventions: new substations, bulk supply points, or line bifurcation. We will be able to address the possibility of spillover within the Greater Accra area somewhat more precisely as we expect an MDE of 0.15 for enterprises there. We will have just a bit less precision when looking at enterprises in the 7 largest cities in the ECG catchment area outside of Greater Accra, where we expect an MDE of around 0.17. This will enable us to say something about the degree to which PDS has impacts in areas where the MCC infrastructure is less likely to have made a difference. As noted above, we plan to coordinate with GridWatch so that we can obtain outage and voltage fluctuation data based on the PowerWatch devices for our survey samples in the Greater Accra area. We expect that this will require approximately 798 PowerWatch devices for the enterprise surveys and another 150 for the household surveys for a total of 948 PowerWatch devices. This is based on an assumption that we will have one transformer per EA and three PowerWatch devices per transformer. In doing these calculations we have assumed no overlap between the transformers used for the household and enterprise surveys. In reality, we expect that there will be some overlap which may enable us to add additional EAs and thereby further reduce our MDIs; however, if the number of devices available are near the estimated required number of 948, we recommend deploying them all appropriately between households and enterprises to help improve our ability to capture outages and voltage fluctuations. See Table X.2. in the EDR for more details.

We plan to estimate impacts of one component of the EEDSM project (rate to retrofit) using an interrupted time series. Our power calculations estimate minimum detectable impacts (MDIs) as a fraction of the mean of the outcome, assuming a simple shift in the mean outcome after the intervention is implemented. In this case statistical power for an ITS model depends on the number of time points of data, the auto-correlation in outcomes, and the coefficient of variation (ratio of the standard deviation of the outcome to its mean). We present results using two ratios of standard deviation to mean-1 and 0.5. These encompass the range of estimates we found on energy use in buildings which went from 0.76 (Hamilton et al. 2013) to 0.49 (Xie et al. 2016). One other paper reported a ratio of 0.57 (Chong 2012). We assume positive auto-correlation and present estimates using both a 0.5 and 0.2 auto-correlation. As table VIII.1 of our Evaluation Design Reports shows the MDIs can be quite large, especially if the ratio of the standard deviation to the mean is high. However it drops as the standard deviation goes down relative to the mean, as the level of auto-correlation falls, as the number of buildings rises, and as the number of time periods rises. Our calculations suggest that if the ratio of the standard deviation to the mean is 0.5, the autocorrelation is 0.2, we have 12 buildings and we can get 48 time periods then we could estimate impacts as small as 0.14 of the mean. We understand that the number of buildings may be somewhat higher than the range presented in this table. This could help improve our statistical precision.

Deviations from Sample Design

Not applicable for evaluation design report.

Response Rate

Not applicable for evaluation design report.

Weighting

Not applicable for evaluation design report.

Questionnaires

No content available

Data Collection

Data Collection Dates

Start	End	Cycle

Data Collection Notes

Unknown because data has not yet been collected.

Supervision

Unknown because data has not yet been collected.

Data Processing

Data Editing

Unknown because data has not yet been collected.

Other Processing

Unknown because data has not yet been collected.

Data Appraisal

Estimates of Sampling Error

Not applicable for evaluation design report.